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SIXTY-SIXTH

ANNUAL REPORT

OF THE

DIRECTOR

OF

THE ASTRONOMICAL OBSERVATORY

OF

HARVARD COLLEGE

FOR THE YEAR ENDING SEPTEMBER 30, 1911

BY

EDWARD C. PICKERING

CAMBRIDGE, MASS.
PUBLISHED BY THE UNIVERSITY
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THE OBSERVATORY

To the President of the University: —

Sir, — The success of a really great institution depends on its adoption and maintenance of a permanent policy. Thus, the Greenwich Observatory has attained its position by observation of the Moon and planets continuously, during more than two centuries. In like manner, for nearly a century, the Pulkowa Observatory has been the highest authority on the absolute positions of the stars. By thirty years of continuous labor, and the expenditure of more than a million dollars, the Harvard Observatory has created a field of work which is not occupied elsewhere, in photometry, photography, and spectroscopy. It is estimated that the equivalent of the entire time of one assistant is now required to furnish replies to the requests for facts which are received here from the observatories of Europe and America. These requests, each year increasing in number, generally relate to the spectrum or brightness of certain stars, and the material for reply exists only at this Observatory. It is obviously desirable that the organization required to supply this demand should be placed on a permanent basis. While no one would suggest that a plan should be continued when more useful work could be found, yet it is the first principle of good business management to provide for a demand as long as it exists. To change an established system in accordance with the wishes of any individual would be as foolish as for the trustees of a great library to convert it into an art museum because they wished to appoint a man having an extensive knowledge of art. In a large institution, the officers must be adapted to the place; in a small one, the plan of work may be changed to accord with the officers.

The excess of the expenses of the Observatory over its income has continued. Accordingly, the photographic work at the Arequipa Station has been diminished, and expenses reduced in other ways. This has not been allowed to interfere with the publication of the Annals, which has made better progress than ever before. The amount accomplished has been limited by the demands of the University on the Publication Office, otherwise, still better progress would have been made. For several years, copy has been supplied more rapidly than it could be printed.

Fortunately, an accumulation of the income of the Quincy Fund has permitted several volumes to be issued, without drawing on the general funds of the Observatory.

The Observatory has suffered a severe loss by the death, on May 21, 1911, of Williamina Paton Fleming, Curator of Astronomical Photographs. She was an Honorary Member of the Royal Astronomical Society, an Honorary Fellow of Wellesley College, and last winter received the gold medal of the Mexican Society of Sciences. Mrs. Fleming's record as a discoverer of new stars, of stars of the fifth type, and of other objects having peculiar spectra, was unequalled. Her gifts as an administrative officer, especially in the preparation of the Annals, although seriously interfering with her scientific work, were of the greatest value to the Observatory.

Observatory Instruments

East Equatorial. — The observations with the 15–inch East Equatorial have been made by Professor O. C. Wendell and have been of the same general character as in previous years. Over eight thousand photometric comparisons have been made, mainly with the polarizing photometer with achromatic prisms. A part of the measurements relate to stars of the Algol type, others to stars whose variability is small, or doubtful, this instrument permitting slight changes to be detected with certainty. More than a thousand settings have been made on Nova Lacertae, and its comparison stars. 184 photometric measures have been made on 12 nights of the nucleus of Brooks' Comet 1911c.

With a second photometer, adapted to the measure of adjacent objects, nearly four thousand settings have been made on double stars. Thirteen eclipses of Jupiter's satellites have been observed photometrically, making 910 in all. 384 settings have been made on δ Orionis, suspected of variability. The occultations of several stars during the Lunar Eclipse of November 16, 1910, were also observed.

Meridian Circle. — The principal work of the Meridian Circle is now substantially completed and published, with the exception of the proper motion of the 8,337 stars contained in the zone $-9^\circ\,50'$ to $-14^\circ\,10'$. The reduction of previous catalogues to 1900.0, for comparison with the results of the present work, has been provisionally completed, and the comparison itself is so far advanced that the study of the systematic differences between the catalogues has been begun, in preparation for the examina-

tion of those stars in which such motions are known, or suspected, to exist. The instrument is now used only for time determinations, and should be reconstructed throughout before it is used for any large investigation.

Henry Draper Memorial

The number of photographs taken with the 11-inch Draper Telescope is 147, making 18,330 in all; with the 8-inch Draper Telescope, 449, making the total number 37,302. The entire number of photographs of the stars taken at Cambridge during the year is 3,796. The Draper Memorial Photographs continue to contribute liberally to our lists of stars having peculiar spectra. Mainly from the study of these photographs, Mrs. Fleming found two new stars, eight variables, two stars having the hydrogen lines bright, one star of the fifth type, and one gaseous nebula. Miss Cannon has found two new stars, ten variables, and two stars in which the hydrogen lines are bright. Miss Mackie has found five variables, Miss Leland and Miss Breslin, one each. The discovery of four novae in a single year is without precedent.

Plans are being made for a Revised Draper Catalogue, covering all parts of the sky, and including about fifty thousand stars of the eighth magnitude, and brighter. The classification of the spectra will be undertaken by Miss Cannon, but the time required to complete the work will depend on the force available for the laborious work of identifying with certainty every spectrum measured.

Various investigations have been carried on by Mr. King, including the determination of the photographic magnitude of the Sun and planets, comparison of the light of the Pole-star with two standard electric lights, kindly furnished by the Bureau of Standards at Washington, variability of the Pole-star and α Orionis, photographs of stars through yellow and blue screens.

Boyden Department

As Mr. Hinkley will leave Arequipa shortly, Mr. Leon Campbell was sent there to take his place, and took charge of the Station on June 1, 1911. He will divide his time between the photographic work and observations of the southern variable stars. The number of photographs taken with the 13-inch Boyden Telescope is 125, making 12,959 in all. 751 photographs were taken with the 8-inch Bache Telescope, making 42,735 in all.

The total number of stellar photographs taken at the Station during the year was 2,042. 642 estimates of variable stars have been made. The weather has continued to be extremely cloudy.

Bruce Photographic Telescope

The number of photographs taken with the 24-inch Bruce Telescope was 205, making a total of 10,509. 35 photographic charts having exposures of two hours were made of the selected areas of Kapteyn. 100 charts having exposures of one hour and 61 special plates were also made.

Blue Hill Meteorological Observatory

The Observatory is directed and supported by Professor A. Lawrence Rotch. Mr. S. P. Fergusson, assistant and mechanician of the Observatory for twenty-four years, resigned to become professor of meteorology at the University of Nevada. The usual observations and records were maintained at the Observatory and its two lower stations. The exploration of the air was continued by means of kites and pilot-balloons. Kites carrying meteorographs were flown on twelve of the days fixed by the International Committee for Scientific Aeronautics, and reached a mean height of 6,825 feet above sea level, which is slightly lower than the average for the two previous years. The maximum altitude was 10,900 feet. The air currents alone were observed with pilot-balloons on five international days, when the wind was insufficient to lift the kites, up to a mean height of 15,650 feet, and a maximum of 27,400 feet.

During the last summer a bulletin was posted daily at the Observatory gate containing the weather forecast, the morning observations, and their departure from normals, which was read by thousands of visitors. Data useful for aerial navigation, collected above Blue Hill, St. Louis, and the Atlantic Ocean, have been published in a series of charts entitled " Charts of the Atmosphere for the Use of Aeronauts and Aviators."

Miscellaneous

Variable Stars. — The continuity of the observation of the northern variable stars of long period is likely to be seriously affected by the absence of Mr. Campbell, in Arequipa. This will, however, enable us to secure observations of the southern stars, many of which have been observed but little. The number

of observations of variable stars communicated to us by other astronomers this year has been unusually large. 1,111 observations have been received from the observers at Amherst College Observatory; 748, from Mr. M. W. Jacobs, Jr., of Harrisburg, Pa.; 544, from Mr. W. T. Olcott, of Norwich, Conn.; 59, by Mr. J. H. Eadie, of Bayonne, N. J.; 56, by Mr. S. C. Hunter, of New Rochelle, N.Y.; and during the last month, 14, by Mr. W. P. Hoge, of Pasadena, Cal. All those sending their observations here the first of each month, are recognized in the publications in *Popular Astronomy* which shows the progress of the work. To increase this material, Circular 166 was issued, pointing out the importance of continuous observations of these stars, which is almost the only way in which an observer with a small telescope can obtain results of real scientific value; also, that it is extremely important that these stars should be followed with large telescopes, when too faint for observation with less powerful instruments. All charts and other material needed for the work were promised to those who could make use of them. The replies have been most gratifying. The Editor of *Popular Astronomy* proposed the formation of a Section of observers, and Mr. W. T. Olcott undertook the laborious work of correspondence and detailed supervision. It seems probable that the amount of valuable material thus collected will be greatly increased.

Observatory of the Rev. J. H. Metcalf. — 55 photographs have been taken by Mr. Metcalf and his assistant with the 12-inch and 6-inch doublets, with an average exposure of 70 minutes. The total number of photographs to December 27, 1910, is 1,153. Owing to Mr. Metcalf's removal from Taunton to Winchester, the telescopes were not used for several months. They have now been remounted in Winchester, and are in working order.

The 16-inch Metcalf Doublet has been in regular use in Cambridge. 686 photographs have been taken, making the total number 1,297. It is now used to supplement, for the northern stars, the work of the Bruce Telescope in Arequipa. A large number of the Kapteyn Selected Areas and Harvard Standard Regions have been photographed. Unfortunately, the illumination of the sky at night by the lights of Boston and Cambridge prevents the use of very long exposures.

An investigation of the greatest importance has been undertaken with this instrument in determining the position of the Moon by photography. 106 plates have been taken, and a dis-

cussion of 11 of them by Professor Russell of Princeton shows that the position of the Moon can be determined in this way with an accuracy slightly greater than that of the best observations with meridian circles.

Additional Investigations. — Besides the work described in other portions of this report, many other investigations are in progress. Miss Leavitt has derived final values of the photographic magnitudes of the sequence of stars near the North Pole. As these magnitudes were derived by several independent methods it is probable that they represent a true scale. Measures of the photographic magnitudes of 48 sequences distributed throughout the sky have been continued by Miss Leland. A systematic search for variable stars in all parts of the sky, mainly by Miss Cannon and Miss Leavitt, is now two-thirds completed. Reduction of the precise positions of sixteen thousand faint stars published in H.A. 1, 2, and 6, by Miss Harwood, is nearly completed and copy for the printer has been prepared for the first five hours.

Library. — The Library of the Observatory has been increased by 288 volumes and 1,675 pamphlets, making the total number 13,530 volumes and 31,272 pamphlets. It is scattered through the various rooms of the Observatory, and continues in constant danger of destruction by fire.

Telegraphic Announcements. — Forty-seven telegraphic announcements have been made, mainly relating to the discovery and observation of comets. They are sent to all who wish for them, free of expense beyond that charged in each case by the telegraphic company. The introduction of the Night Letter system permits messages to be sent in ordinary language, instead of in cipher, without increased expense, and generally without serious delay. A change in the rules of the telegraph company has doubled the cost of the cipher messages on land lines. Subscribers are given the option of either service.

Cablegrams intended for this Observatory should be addressed "Observatory, Boston," and all telegrams, "Harvard College Observatory, Cambridge, Mass." All correspondence should be addressed to the Director.

Forty-two neostyle bulletins have been issued, making the total number 467. They form a very quick and convenient method of keeping astronomers informed of current work. Many interesting facts are communicated to us and thus distributed to our subscribers without charge.

Publications. — Good progress has been made in the publication of the Annals, and it is expected that still better results, as regards the completion of volumes, will be made during the coming year. **56**, No. **5**; **59**, Nos. **6**, **7**, and **8**; **64**, No. **7**; **65**; **66**; **68**, Part **2**; **71**, No. **1**, have been distributed. Of the unfinished volumes, **47**, Part **2**, Photographic Magnitudes of 107 Variable Stars of Long Period, is nearly completed, and will be sent to the printer in a few weeks. **56**, No. **6**, Stars having Peculiar Spectra, is about two-thirds in type. **59**, No. **9**, Tests of Photographic Plates, 1902 to 1910, is in the hands of the printer. **61**, Part **3**, A Statistical Investigation of Cometary Orbits, is in type. **62**, Part **2**, Ledgers of Stars in the Zone $-9°\ 50'$ to $-14°\ 10'$, is printed and at the binders. **63**, Part **1**, Observations of 328 Variable Stars of Long Period, is nearly all in type. **67**, Catalogue of 8,337 Stars in the Zone $-9°\ 50'$ to $-14°\ 10'$, was sent to Germany to be printed, more than a year ago. Proof of the first few pages has recently been sent to us. **71**, No. **2**, Spectra and Photographic Magnitudes of Stars in Standard Regions, is ready for distribution. **72**, No. **1**, Position of the Moon determined Photographically, is in type. **72**, No. **2**, 1655 New Nebulae, is in the hands of the printer. A few pages of **73**, Part **1**, Blue Hill Meteorological Observations, 1909, are in type.

The set of the Annals, from **1** to **60**, is therefore completed and distributed, with the exception of portions of **47**, **56**, and **59**. **65**, **66**, **68**, **70**, and portions of **61**, **62**, **64**, **69**, and **71** are also distributed. **74** is the first volume which is not partly in type. It is hoped that **1** to **70** will be completed this year with the exception of Part **2** of **63**, and **69**. A description of the contents of the Annals is also in type.

Four Circulars have been issued, whose numbers, titles, and dates are as follows: —

163. *181325.* Nova Sagittarii, No. 3. H.V. 3306. January 19, 1911.
164. Nova Sagittarii, No. 4. Five New Variable Stars. March 18, 1911.
165. Three New Variable Stars in Harvard Map, No. 22. April 10, 1911.
166. Coöperation in Observing Variable Stars. June 29, 1911.

Various other publications by officers of the Observatory are described in the *Harvard University Gazette*, each month.

EDWARD C. PICKERING, *Director.*